

TESTIMONY / COMMENTS OF SUSAN C. PAULSEN, PH.D., P.E.,
IN RESPONSE TO THE RENEWAL OF WASTE DISCHARGE REQUIREMENTS AND
THE NPDES PERMIT (NO. CA0077682) FOR SACRAMENTO REGIONAL COUNTY
SANITATION DISTRICT, SACRAMENTO REGIONAL WASTEWATER TREATMENT
PLANT BEFORE THE CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL
BOARD

On Behalf of the
SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT (SRCSD)

I am Susan C. Paulsen, Ph.D., P.E. I am employed as Vice President and Senior Scientist by Flow Science Incorporated. I have a B.S. in Civil Engineering from Stanford University (1990, with honors), and a M.S. in Civil Engineering and a Ph.D. in Environmental Engineering Science from the California Institute of Technology (Caltech) (1993, 1997). I am registered in California as a Professional Civil Engineer, and I have over 15 years of professional consulting experience. I have worked for the past 13 years with Flow Science Incorporated, in Pasadena, CA. My consulting engineering work has focused on projects involving environmental fate and transport. I have expertise in designing and managing hydrodynamic modeling studies to evaluate constituent transport and mixing, and I have conducted numerous water quality analyses for storm water runoff, NPDES permitting, irrigation, and wastewater and industrial process water treatment facilities. I oversee water quality regulatory and policy analysis for Flow Science. Attached hereto is a true and correct copy of my resume.

I directly prepared, or supervised the preparation of the numerous documents, or sections therein, pertaining to the mixing of the Sacramento Regional Wastewater Treatment Plant (SRWTP) effluent discharged through the SRWTP diffuser into the Sacramento River, water temperature downstream of the discharge, and water quality within the Sacramento River and Delta as a result of the SRWTP discharge, which have been provided to the Central Valley Regional Water Quality Control Board staff. The documents, with brief descriptions of those most important to my conclusions, include:

a. Sacramento County Department of Environmental Review and Assessment (SCDERA) and EDAW Inc. (2003). Sacramento Regional Wastewater Treatment Plant 2020 Master Plan, Draft Environmental Impact Report for the Sacramento Regional County Sanitation District. Volume 2 – Technical Appendices F, I, and K. Control Number 97-PWE-0599, State Clearinghouse Number: 2002052004. August.

Appendix F describes in extensive detail the hydrodynamic modeling methodology used by Flow Science to evaluate the concentrations of relevant constituents resulting from the SRWTP discharge at Freeport. Specifically, the Appendices describe how statistical distributions were calculated to describe the concentrations of various water quality constituents within the plume in the near-field—i.e., within the 700-foot region immediately downstream of the SRWTP diffuser—and for the far-field—i.e., at important, but distant, points in the

Sacramento-San Joaquin River Delta. Appendices I and K present results of this modeling, in both tabular and color graphical formats.

b. Flow Science Incorporated (2006a). Model Sensitivity Analysis for FLOWMOD Simulations of the SRCSD Effluent Discharge to the Sacramento River at Freeport, CA. Prepared for Sacramento Regional County Sanitation District. September.

c. Flow Science Incorporated (2006b). Results of October 2005 Field Dye Study of the Sacramento Regional County Sanitation District Effluent Discharge to the Sacramento River at Freeport, California. Prepared for Sacramento Regional County Sanitation District. October.

d. Flow Science Incorporated (2006c). Results of the June 2006 Dye Study of Effluent Discharge to the Sacramento River at Freeport, California. Prepared for Sacramento Regional County Sanitation District. November.

e. Flow Science Incorporated (2006d). Model Verification Results for FLOWMOD Simulations of SRCSD Effluent Discharge to the Sacramento River at Freeport, June 2006 Field Study. Prepared for Sacramento Regional County Sanitation District. November.

f. Flow Science Incorporated (2007a). Results of the November 2006 Dye Study of Effluent Discharge to the Sacramento River at Freeport, California. Prepared for Sacramento Regional County Sanitation District. May.

g. Flow Science Incorporated (2007d). FLOWMOD Scaling Analysis of Modified SRWTP Diffuser at Freeport, CA. Prepared for Sacramento Regional County Sanitation District. July.

h. Flow Science Incorporated (2007e). Analysis of Water Quality Effects of Modified Diffuser Scenarios, Sacramento Regional Wastewater Treatment Plant. Prepared for Sacramento Regional County Sanitation District. July.

i. Flow Science Incorporated (2008b). Model Verification Results for FLOWMOD Simulations of SRCSD Effluent Discharge to the Sacramento River at Freeport, November 2007 Field Study. Prepared for Sacramento Regional County Sanitation District. June.

Documents c through i include the results of four field dye studies and model verification analyses based upon those field studies. Field dye studies were used to gather data to be used in validating Flow Science's three-dimensional hydrodynamic FLOWMOD model of this region of the Sacramento River. The field dye studies from October 2005, June 2006, and November 2006 revealed the transient presence of elevated concentrations of effluent near the east bank of the river during low river flow conditions (i.e., just prior to flow reversals). Subsequently, and based upon both field and model results, Flow Science recommended that the twenty-five (25)

easternmost ports of the diffuser be closed in order to restore the diffuser's designed uniform mixing regime and to minimize the elevated effluent concentrations near the east bank of the river. The field dye and model verification study performed in November 2007 showed that closing the ports restored the SRWTP diffuser design mixing function and minimized the flow of nearly undiluted effluent at the surface of the River near its east bank during low river flow conditions. The results of these field dye studies and model verification studies indicate that the model results correspond well with field data and that the model is generally conservative (i.e., overpredicts effluent concentrations within the plume), particularly during conditions of low river flow.

j. Larry Walker Associates (LWA) (2009). Antidegradation Analysis for Proposed Discharge Modification for the Sacramento Regional Wastewater Treatment Plant. Prepared for Sacramento County Regional Sanitation District. May. Sections 5.1.1, 5.3.1, 5.4.1, 5.4.3, significant portions of sections 5.4.6-16, significant portions of sections 5.5.4-9, and significant portions of sections 5.6.4-30.

Flow Science contributed (in the report sections noted above) the results of water quality modeling that compared constituent concentrations resulting downstream of the SRWTP for the two relevant discharge scenarios (i.e., 181 mgd and 218 mgd).

k. Robertson-Bryan Inc. (RBI) (2010). Thermal Plan Exception Justification for the Sacramento Regional Wastewater Treatment Plant. Prepared for Sacramento Regional County Sanitation District. July. Sections 4.1.1, 4.2.2.

Flow Science supported the analysis in this report by providing modeling results that show the effect of the SRWTP discharge on Sacramento River temperatures downstream of the diffuser—both in the near-field zone, and in the far-field fully-mixed zone—both under existing discharge conditions and under the conditions of the proposed Thermal Plan exceptions.

l. LWA (2010a). Flow Science LTAs at the 218 mgd Effluent Flow Condition – Preliminary. Submitted to the Central Valley Regional Water Quality Control Board. April.

This document is a table of data showing the Long Term Average (LTA) concentrations for certain constituents that could be discharged from SRWTP while still meeting relevant water quality criteria at particular distances downstream of the SRWTP diffuser. Flow Science used DYNTOX to generate LTA concentrations. LTA concentrations for cyanide, copper, mercury, and ammonia were presented in this document, for the 218 mgd (ADWF) discharge condition. These LTA values were *not* used by the Central Valley Regional Water Quality Control Board in determining relevant water quality limitations in the recently proposed SRWTP NPDES discharge permit, since the SRCSD is no longer requesting that discharge be allowed to increase from 181 mgd to 218 mgd.

m. LWA (2010b). Flow Science LTAs at the 181 mgd Effluent Flow Condition – Preliminary. Submitted to the Central Valley Regional Water Quality Control Board. April.

This document is a table of data showing the Long Term Average (LTA) concentrations for certain constituents that could be discharged from SRWTP while still meeting relevant water quality criteria at particular distances downstream of the SRWTP diffuser. Flow Science used DYNTOX to generate LTA concentrations. LTA concentrations for cyanide, copper, mercury, and ammonia were presented in this document, for the 181 mgd (ADWF) discharge condition.

n. Flow Science Incorporated (2010a). Long Term Average (LTA) Calculations for Chlorpyrifos (Acute and Chronic) and Nitrate-Nitrogen, 181 mgd. Calculations prepared for LWA and SRCSD. July.

o. Flow Science Incorporated (2010b). Total phosphorus concentrations in the plume immediately downstream of the SRWTP diffuser. Revised calculations prepared for LWA and SRCSD. August.

p. In addition to these formal reports, I met and communicated both with the Independent Technical Review Committee convened in 2001 and with EPA's technical consultant TetraTech, who provided peer review of the dynamic modeling and DYNTOX analysis approach on behalf of the Central Valley Regional Board, to provide detailed explanations and presentations of the dynamic and DYNTOX modeling approaches and model results and to respond to questions posed by the peer reviewers.

q. Flow Science, under my supervision, provided flow and water quality simulations furnished by SRCSD to Regional Board staff during the period preceding the development of the Tentative Permit released on September 3, 2010, in response to questions from Board staff and to assist otherwise in understanding effects of the SRWTP discharge.

r. Flow Science, under my supervision, also provided SRCSD with the flow and water quality simulations and analysis reflected in SRCSD's comments on the Tentative Permit released on September 3, 2010.

The above documents accurately provide information used to develop my analyses and opinions.

The information listed above, including both model results and field data, have been used by me and by Flow Science Incorporated to describe the mixing of effluent from the SRWTP with Sacramento River water following discharge from the SRWTP diffuser at Freeport, and temperature and concentrations of effluent within the discharge plume.

The dynamic modeling and DYNTOX analyses described above have been used by me and by Flow Science Incorporated to calculate statistical probability distributions

describing temperature and the concentrations of water quality constituents within the plume downstream of the SRWTP diffuser. I have also assisted in preparing materials to assist Regional Board staff and peer reviewers in understanding work performed by Flow Science, and have participated in meetings with Regional Board staff and peer reviewers for the same purpose.

Based on my education, training, and experience, including my specific experience with the SRWTP and Sacramento River and Delta, I have the following opinions:

1. The simulations provided to Regional Board staff as described above and as validated by field studies are an appropriate and reliable basis for evaluating and comparing effects on water quality and temperature associated with the SRWTP discharges, in both the near-field and far-field, and the results tend to be conservative as compared with field data.

2. Results of the dynamic modeling we have employed in our analyses are far more reflective of actual conditions in the Sacramento River and Delta, and are thus more appropriate as a basis for effluent limitations, than the "steady state" approach of the State Implementation Plan (SIP), which was used in formulating the Tentative Permit as described therein at pages F-22 through F-29. The SIP steady-state approach to calculating effluent limitations uses a single set of "critical conditions" (e.g., for river and effluent hardness, pH, temperature, or flow rate) to set end-of-pipe effluent limitations. As such, the steady-state approach does not account for the frequency with which various effluent and river conditions actually occur, or for the details of mixing on receiving water concentrations within the discharge plume downstream of the SRWTP diffuser. The steady-state SIP approach also does not account for the tidally dynamic nature of flows in the Sacramento River at Freeport, or for the effects that occur as a result of upstream (reverse) tidal flows in the river. In contrast, the dynamic modeling approach we have employed explicitly accounts for the full range of observed historic conditions because it is based on rigorous statistical descriptions of important parameters, including river and effluent flow rate, pH, hardness, temperature, and ambient and effluent water quality constituent concentrations. The dynamic modeling approach simulates tidal dynamics within the river and the effects of flow reversals by using an hourly timestep rather than daily average flow conditions. It would be more appropriate to calculate effluent limitations based upon the results of the dynamic modeling approach, as this approach produces a far more accurate, yet still conservative, description of constituent concentrations at specific locations within the effluent plume, and of the frequency at which specified thresholds (typically water quality objectives) would be exceeded.



RESUME

SUSAN C. PAULSEN, Ph.D., P.E.
Vice President and Senior Scientist

EDUCATION

Ph.D. Environmental Engineering Science, California Institute of Technology, 1997
M.S. Civil Engineering, California Institute of Technology, 1993
B.S. Civil Engineering (with honors), Stanford University, 1990

REGISTRATIONS AND CERTIFICATES

Professional Engineer (Civil) in California (C66554)

SUMMARY

Dr. Paulsen has been employed at Flow Science since 1997, where she has project responsibility for work involving environmental fate and transport. Dr. Paulsen has expertise in designing and managing modeling studies to evaluate transport and mixing, and she has conducted water quality analyses for storm water runoff, NPDES permitting, irrigation, and wastewater and industrial process water treatment facilities. At Flow Science she has been involved in projects combining hydrodynamics, aquatic chemistry, and the environmental fate of various constituents. Dr. Paulsen oversees water quality regulatory and policy analysis for Flow Science.

SELECTED EXPERIENCE

Project Manager, Boeing SSFL Stormwater Analysis and NPDES Permit Assistance, Canoga Park, CA

Dr. Paulsen provided data review, hydrologic modeling, autosampler program design and NPDES permit assistance. Specific services included review of existing BMPs at the site and recommendation of changes to BMP practices, and preparation of scientific reports related to background concentrations of regulated constituents and the impact of wildfires on storm runoff water quality. Flow Science designed an autosampler program for the collection of flow-weighted composite samples for the purpose of evaluating permit compliance, believed to be the first program of this type in California, and Dr. Paulsen has provided testimony on multiple occasions to both the Regional and State Water Boards related to this permit. Flow Science has also prepared technical and scientific reports related to the source of metals and dioxin/furan compounds in storm flow from the site and from the region.

Project Manager and Lead Engineer, Legal Support Services for NPDES and TMDL Issues

Dr. Paulsen provided technical support for legal actions involving NPDES permits and appeals. Dr. Paulsen provided data analysis, technical support, and expert witness and coordination services related to legal issues on NPDES permit appeals (including issues related to regulation of storm water, numeric limits, and implementation of TMDLs in NPDES permits), Clean Water Act third-party citizens' suits (involving violations of receiving water limitations in NPDES



permits), USEPA enforcement actions (involving discharges that were initially unreported), and Basin Planning (involving triennial review processes and Basin Plan development and implementation).

Review of the Administrative Record for the Los Angeles Basin Plan

Susan C. Paulsen, Ph.D., P.E., and E. John List, Ph.D., P.E., conducted a thorough review of the complete administrative record for the Los Angeles Basin Plan. The study was undertaken to review state and national water quality regulations and policy documents, and to assess regulatory compliance actions within the Los Angeles Region for conformity with these policies and regulations. The study provided a comprehensive evaluation of the designation of beneficial uses, the establishment of water quality objectives, and the implementation of the Basin Plan in the NPDES permitting process, the TMDL process, and other regulatory actions. The published study identified four priority areas for Basin Plan reform, and made a number of recommendations for changes to water quality regulation within the Region.

Project Manager and Lead Engineer, San Gabriel River Metals TMDL

Provided water quality analysis and regulatory assistance. Dr. Paulsen assisted LADWP and a number of local municipalities in reviewing total maximum daily loads (TMDLs) for metals in the San Gabriel River as prepared by the Regional Water Board and as subsequently adopted by USEPA. Flow Science evaluated water and sediment quality data, evaluated modeling and analyses and prepared comments.

Project Manager and Lead Engineer, Shell Oil Carson Terminal NPDES Permitting

Shell Oil Products US, Carson Terminal, retained Flow Science and GeoSyntec Consultants, Inc. (GeoSyntec) to review available information and data related to their current Storm Water Pollution Prevention Plan (SWPPP), Storm Water Monitoring Plan (SWMP), and National Pollution Discharge Elimination System (NPDES) Storm Water Permit. Flow Science reviewed the regulatory basis for the current NPDES permit, which includes numeric effluent limitations based on California Toxics Rule (CTR) criteria. Flow Science also evaluated how CTR levels could be used as a basis for the derivation of scientifically appropriate permit limits. A review and evaluation of emergency storm water discharge and receiving water data collected and reported by the Carson Shell Terminal and the Los Angeles County Department of Public Works (LACDPW) was also conducted by Flow Science. This analysis focused on constituents of concern identified at the Shell Carson Terminal, including the metals copper, lead, zinc, and nickel.

Project Manager, Advisory Committee for Sediment Quality Objectives

As a member of the State Water Board's Advisory Committee on the development of Sediment Quality Objectives (SQO), Dr. Paulsen has participated in meetings with the State Board's Science Team, the Scientific Steering Committee, and the State Board related to the development of SQO for direct effects (effects to biota living in sediments) and indirect effects (to humans from consumption of organisms contaminated with sediment-borne pollutants). Flow Science has reviewed scientific data and literature on sediment quality, sediment toxicity, and biological indices, and has provided written comments and testimony to the State Water Board.



Project Manager and Engineer, Rock Slough Water Quality Improvement Project, Sacramento Delta, CA

Dr. Paulsen analyzed sources of water quality degradation in Rock Slough. She provided field surveys, a review of existing water quality data, study design for collection of additional water quality data, Delta flow and water quality modeling using the Fischer Delta Model (FDM). Dr. Paulsen also evaluated alternatives for improving water quality, including adjustments to tidally operated gates and relocation of point sources of salinity.

Project Manager and Engineer, Sacramento Wastewater Treatment Plant Outfall, Freeport, CA

Flow Science and Dr. Paulsen continue to provide dilution analysis and support for the Sacramento Regional Wastewater Treatment Plant discharge of treated wastewater to the Sacramento River at Freeport. Since the late 1980's, Flow Science has designed and supervised five field dye studies to determine the mixing behavior of the discharge under a variety of conditions. Dr. Paulsen has also assisted SRWTP's permitting and planning processes by evaluating the impacts of the SRWTP discharge on water quality and temperature in the near-field and within the Delta. She continues to provide modeling and analysis in support of the district's ongoing master planning, EIR, and NPDES permitting processes.

Project Manager, Design and Management of Special Studies Pursuant To the Los Angeles River Metals TMDL

Dr. Paulsen has developed conceptual study designs for three special studies designed to address scientific issues that were unresolved when the Los Angeles River Metals TMDL was adopted in July 2005. Flow Science developed detailed plans to measure dry deposition of four metals to undeveloped, open space areas adjacent to the urbanized area of the watershed, together with storm flow measurements of the metals in the flows from the subwatersheds where deposition plates would be located; this study is planned for the future. Flow Science also assisted in the planning and development of a work plan for a special study to assess water quality objectives for metals in the Los Angeles River; these studies will involve a water effects ratio (WER) study for copper and a recalculation study for lead and will commence soon. Dr. Paulsen has been an active participant on the Steering and Technical Committees for these studies, working with Regional Board staff and local stakeholders, including local cities, the County Department of Public Works, LACSD, and Caltrans, to communicate the details of and need for the studies, and to obtain approval and funding. Flow Science is providing project oversight and management throughout the duration of all the studies.

Project Manager, Mountain House Wastewater Treatment Plant Dye Study and Discharge Modeling

Dr. Paulsen managed a study to inject a fluorescent dye into treated wastewater discharged from the Mountain House Treatment Plant to the South Delta, west of Tracy, California. The dye study was used to establish the dilution of the discharge to the Delta and to validate a computer model describing hydrodynamics and the transport of solutes in the Delta. The model was subsequently used to simulate the fate and dilution of the discharge under a range of hypothetical future conditions, including changes to Delta operations and South Delta barrier schedules. Results of the study were accepted by the National Marine Fisheries Service (NMFS) as satisfying the provisions of a 2006 Biological Opinion that required a special study to characterize dilution and verify assumptions made during NPDES permit development.